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09/978,275	10/17/2001	Masahiko Yamada	Q66727	4449

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EXAMINER	
MACKOWEY, ANTHONY M	
ART UNIT	**PAPER NUMBER**
2623	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/978,275	YAMADA, MASAHIKO
	Examiner	Art Unit
	Anthony Mackowey	2623

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 October 2001*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-21* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-21* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *17 October 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *10/17/01 & 9/29/03*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

Drawings

The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: "100". Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-5,7,9,11-13 and 20 are rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent 6,173,084 to Aach et al. (Aach).

As to claim 1, Aach discloses, an apparatus for suppressing noise in an input image signal representing a radiographic image (col. 6, lines 10-40; Fig. 1), comprising:

a smoothing unit which processes said input image signal by using a smoothing filter so as to smooth said radiographic image (col. 6, lines 42-55, Aach teaches the filters "41","42" and "43" generate the filtered (smoothed) detail image signals); and

a characteristic calculation unit which obtains at least one first characteristic of said input image signal by calculation based on first information indicating an exposure does with which said radiographic image has been produced (col. 9, lines 40-48, The disclosed elements derive the local gradients from the pixel values of the input detail images derived from the original image signal. The original input signal being directly affected by exposure does and the apparatus used to generate the image.);

said smoothing unit adapts at least one second characteristic of the smoothing filter to said input image signal based on said at least one first characteristic (col. 6, lines 60-65, From the equation col.6, line 64 one can see the weighting factor α employed by the smoothing filter is a function of the derived local gradient value discussed above.).

As to claim 2, Aach further discloses an apparatus further comprising a band-limited-image-generation unit which generates a plurality of band limited image signal respectively representing a plurality of band-limited images belonging to a plurality of different frequency bands, based on said input image signal (col. 6, lines 10-14; Fig. 3),

said smoothing unit processes said plurality of band-limited image signals by sing said smoothing filter so as to smooth each of said plurality of band-limited images (col. 6, lines 28-35, Aach teaches each of the frequency-band image signals is applied to a filter, which supplies the filtered (smoothed) detail image.).

As to claim 3, Aach further discloses an apparatus wherein said band-limited-image-signal generation unit generates said plurality of band-limited image signals by performing multiresolution decomposition of said input image signal (col. 6, lines 12-18, Aach teaches a plurality of frequency-band image signals at several resolution levels).

As to claim 4, Aach further discloses an apparatus wherein said characteristic calculation unit obtains said at least one first characteristic of said input image signal base on second information locally calculated from pixel values in a neighborhood of a pixel of interest in at least one of said plurality of band-limited images represented by at least one of said plurality of band-limited image signals, as well as said first information (col. 3, lines 22-35, Aach teaches that the weight factor is obtained by finding the direction in which the neighboring pixel is located in the current detail image with respect the to pixel being filtered (pixel of interest) and calculating the magnitude of the difference between the pixels in said direction (pixel vector).).

As to claim 5, Aach further discloses an apparatus wherein said characteristic calculation unit obtains a pixel vector at said pixel of interest in said at least one of said

plurality of band-limited images (col. 3, lines 22-35, Aach teaches that the weight factor is obtained by finding the direction of a neighboring pixel with respect the to pixel being filtered and calculating the magnitude of the difference between the pixels in said direction (pixel vector).), and detects an orientation of an edge as said second information (col. 4, lines 14-31) Aach teaches how the weighting factors take into account the direction and magnitude of gradients and how they indicate an edge), and

said smoothing unit arranges said at least one second characteristic of said smoothing filter so that said radiographic image is smoothed along said orientation of said edge (col. 4, line 14-45, Aach teaches the weighting factors are appropriately calculated according to gradient directions in order to preserve edge structures.).

As to claim 7, Aach discloses a method for suppressing noise in an input image signal representing a radiographic image (col. 1, lines 35-37), said method comprising the steps of:

(a) obtaining at least one first characteristic of said input image signal by calculation based on information indicating an exposure does with which said radiographic image has been produced (col. 9, lines 40-48, The disclosed elements derive the local gradients from the pixel values of the input detail images derived from the original image signal. The original input signal being directly affected by exposure does and the apparatus used to generate the image.);

(b) adapting at least on second characteristic of a smoothing filter to said input image signal based on said at least one first characteristic (col. 6, lines 60-65,

From the equation col.6, line 64 one can see the weighting factor α employed by the smoothing filter is a function of the derived local gradient value discussed above); and

(c) processing said input image signal by using said smoothing filter so as to smooth said radiographic image (col. 6, lines 42-55, Aach teaches the filters "41","42" and "43" generate the filtered (smoothed) detail image signals).

As to claim 9, Aach discloses a method for suppressing noise in an input image signal representing a radiographic image, said method comprising the steps of:

(a) generating a plurality of band-limited image signals respectively representing a plurality of band-limited images belonging to a plurality of different frequency bands, based on said input image signal (col.6, lines 10-14);

(b) obtaining at least one first characteristic of said input image signal by calculation based on information indicating an exposure dose with which said radiographic image has been produced (col. 9, lines 40-48, The disclosed elements derive the local gradients from the pixel values of the input detail images derived from the original image signal. The original input signal being directly affected by exposure does and the apparatus used to generate the image.);

(c) adapting at least one second characteristic of a smoothing filter to said input image signal based on said at least one first characteristic (col. 6, lines 60-65, From the equation col.6, line 64 one can see the weighting factor α employed by the smoothing filter is a function of the derived local gradient value discussed above); and

(d) processing said plurality of band-limited image signals by using said smoothing filter so as to smooth each of said plurality of band-limited images (col. 6, lines 28-35, Aach teaches each of the frequency-band image signals is applied to a filter, which supplies the filtered (smoothed) detail image.).

As to claim 11, Aach discloses an apparatus for suppressing noise in an input image signal representing a radiographic image, comprising:

a band-limited-image-signal generation unit which generates a plurality of band-limited image signals respectively representing a plurality of band-limited images belonging to a plurality of different frequency bands, based on said input image signal (col. 6, lines 10-14, Fig. 3);

an index value obtaining unit which obtains at least one index value indicating a degree of suppression of said noise, based on information indicating an exposure dose with which said radiographic image has been produced (col. 6, lines 42-65, Aach teaches that the filters compute the local weighted average, this includes the calculation of the weighting factor α, these weighting factors are normalized so that the sum over the region is unity, thus the weighting factor α is an index value indicating a degree of suppression.);

a noise suppression unit which processes each of said plurality of band-limited image signal so as to suppress noise in each of said plurality of band-limited images based on said at least one index value (col. 6, lines 42-65).

As to claim 12, Aach further discloses the index value obtaining unit obtains said at least one index value indicating the degree of suppression of the noise for each of said plurality of band-limited image signals (col. 6, lines 42-65, Aach teaches that a weighting factor α is calculated for each pixel at each resolution level, thus at least one index value indicating a degree of suppression is calculated for each image signal), and

Said noise suppression unit process each of said plurality of band-limited image signals so as to suppress the noise in each of said plurality of band-limited images based on said at least one index value obtained for said each of a said plurality of band-limited image signals (col. 6, lines 42-65).

As to claim 13, Aach further discloses said index-value obtaining unit obtains said at least one index value indicating the degree of suppression of the noise for each pixel of each of said plurality of band-limited images (col. 6, lines 42-65, Aach teaches that a weighting factor α is calculated for each pixel at each resolution level), and

Said noise suppression unit processes each of said plurality of band-limited image signals so as to suppress noise in said each pixel of each of said plurality of band-limited images based on said at least one index value obtained for said each pixel of said each of said plurality of band-limited images (col. 6, lines 42-65,).

As to claim 20, Aach discloses a method for suppressing noise in an input image signal representing a radiographic image, said method comprising the steps of:

(a) generating a plurality of band-limited image signals respectively representing a plurality of band limited images belonging to a plurality of different frequency bands, based on said input image signal (col. 6, lines 10-14);

(b) obtaining at least one index value indicating a degree of suppression of said noise (col. 6, lines 42-65, Aach teaches that the filters compute the local weighted average, this includes the calculation of the weighting factor α, these weighting factors are normalized so that the sum over the region is unity, thus the weighting factor α is an index value indicating a degree of suppression.) based on information indicating an exposure does with which said radiographic image has been produced (col. 9, lines 40-48, The disclosed elements derive the local gradients from the pixel values of the input detail images derived from the original image signal. The original input signal being directly affected by exposure does and the apparatus used to generate the image.); and

(c) processing each of said plurality of band-limited image signals so as to suppress noise in each of said plurality of band-limited images based on said at least one index value (col. 6, lines 42-65).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Aach in view of U.S. Patent to 5,351,305 to Wood et al. (Wood).

Aach discloses all the limitation of the apparatus according to claim 1. Aach does not disclose the smoothing filter includes for each of a plurality of predetermined directions a plurality of filters respectively smoothing said radiographic image in said each of a plurality of predetermined directions to a plurality of different degrees, or

said smoothing unit adapts said at least one second characteristic of said smoothing filter to said input image signal by selecting on of said plurality of filters based on said at least one first characteristic of said input image signal.

Wood discloses a smoothing filter that includes a plurality of filters at predetermined directions (col. 5, lines 7-13, Wood also teaches that the filters are at 10 degree increments), and that the smoothing filter selects one of the plurality of filters based on at least one characteristic of the input image signal (col. 4, lines 61-68, Wood teaches comparing the angle of the edge with the preselected array of directions corresponding to the directions of preselected directional filters.).

The teachings of Aach and Wood are combinable because they are both in the same field of endeavor, namely smoothing and edge enhancement in medical imaging. It would have been obvious to on of ordinary skill in the art at the time the invention was made to modify the apparatus (namely the smoothing unit) of Aach to include a plurality of directional filters which the smoothing unit selects based on the input image signal as taught by Wood. One of ordinary skill would have been motivated to do so because by having a plurality of filters at different angles, the smoothing unit would select a filter

close to parallel with the edge. This would allow for smoothing of the image with reduced blur along edges, thus improving visibility and definition of structures, which is extremely important in medical imaging.

Claims 8,10 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 6,173,084 to Aach et al. (Aach).

Claims 8,10 and 21 are computer-readable storage medium claims, which correspond to claims 7, 9 and 20 respectively. Arguments analogous to those presented above with respect to claims 7,9 and 20 are applicable to claims 8,10 and 21. While Aach is silent with regard to the computer-readable storage medium storing a program which instructs a computer to execute a method for suppressing noise in an input image signal representing a radiographic image, Aach discloses the image processor according to the invention particularly suitable for performing the method according to the invention may be carried out by a suitably programmed computer. However, it is well known that computers utilize hard disk drives to store data such as programs. CD ROMs and other portable storage devices are also widely used to store computer programs for implementation on a computer. One would have been motivated to include a computer-readable storage medium, such a CD ROM, to store a computer program because they have high storage capacity, are relatively cost effective, and are very stable for safe, permanent storage.

Claims 14-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 6,173,084 to Aach et al. (Aach) in view of U.S. Patent Publication 2002/0094114 by Ogino.

As to claim 14, Aach discloses all the limitations of claim 12. Aach further discloses the index-value obtaining unit obtains a first evaluation value from a first one of said plurality of band-limited image signals belonging to a first one of said plurality of different frequency bands and a second evaluation value from a second one of said plurality of band-limited image signals belonging to a second one of said plurality of different frequency bands which is lower than said first one of said plurality of different frequency bands. Aach also discloses the filtered detail images are adjusted on the basis of gradients in the detail image of the next courser resolution level and obtains a degree of suppression of the noise for said first one of said plurality of band-limited image signals (col. 6, lines 42-65, Aach discloses calculations and filtering are performed for each respective resolution level.). Aach does not disclose determining weights based on said information indicating exposure does with which the radiographic image has been produced, for use in a weighted sum of said first and second evaluation values, obtains said weighted sum, and obtains based on said weighted sum at least one index value indicating the degree of suppression of the noise for said first one of said plurality of band-limited image signals. However, Ogino teaches summing the variance of pixel values of neighboring slices in a series of multislice images and that an appropriate weight may be applied in the addition (paragraph 0123- 0125; Fig. 10). This

new variance value is then used to determine (evaluate) the suppression of the current pixel (paragraphs 0111-0119).

The teachings of Aach and Ogino are combinable because they are both in the same field of endeavor, namely, processing of medical images. It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the apparatus disclosed by Aach perform the process of obtaining a weighted sum of first and second evaluation values as taught by Ogino, then obtain the index value indicating the degree of suppression. One would have been motivated to combine these teaching because it would provide a more exact pixel value adjustment (Ogino, paragraph 0126) and better distinguishes structures between image structures that appear on several resolution levels and image structures at only a few resolution levels (Aach, col. 2, lines 6-11).

As to claim 15, Aach further discloses said index-value obtaining unit obtains each of said first and second evaluation values for each pixel of one of said plurality of band-limited images corresponding to said each of evaluation values, based on pixel values of said one of said plurality of band-limited images in a neighborhood of said each pixel (col. 3, lines 22-35, Aach teaches that the weight factor is obtained by finding the direction in which the neighboring pixel is located in the current detail image with respect the to pixel being filtered (pixel of interest) and calculating the magnitude of the difference between the pixels in said direction (pixel vector).).

As to claim 16, Aach further discloses said index-value obtaining unit obtains as each of said first and second evaluation values a pixel vector at each pixel of one of said plurality of band-limited images corresponding to said each of said at least one index value based on at least one of a length and an orientation of said pixel vector (col. 3, lines 22-35, Aach teaches that the weight factor is obtained by finding the direction in which the neighboring pixel is located in the current detail image with respect the to pixel being filtered (pixel of interest) and calculating the magnitude of the difference between the pixels in said direction (pixel vector).).

As to claim 17, Aach further discloses the apparatus obtains at said at least one index value at least one of a degree of edge confidence (col. 4, lines 65-68, Aach discloses the sum of gradients represents the position and strength of edges in the image), an amount of pixel energy, and a vector orientation (col. 3, line 64- col. 4, line 5, Aach teaches that the relative directions of corresponding vectors (vector orientation) determine the weights in order to reduce noise, that is, it determines whether signal is structure or noise (pixel energy)).

Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over U.S Patent 6,173,084 to Aach et al. (Aach) in view of U.S. Patent 5,550,888 to Neitzel et al. (Neitzel).

As to claim 18, Aach discloses all the limitations of the apparatus according to claim 11, and wherein said noise suppression unit processes one of said plurality of

band-limited image signals so as to generate a transformed image signal. Aach does not disclose obtaining a weighted sum of said one of said plurality of band-limited image signals and said transformed image signal by using weights determined based on said at least one index value. However, Neiztel discloses a method in which a transformed low-pass image is summed with the original input image (col. 6, lines 38-45).

The teachings of Aach and Neiztel are combinable because they are both in the same field of endeavor, namely, processing of X-ray images. It would have been obvious to one of ordinary skill in the art at the time the invention was made for the apparatus disclosed by Aach, perform the process of obtaining a weighted sum a band-limited image signal and the transformed image. One would have been motivated to do this because it would result (less processed) looking image, making it easier to read and interpret when the plurality of resolution images are recombined, and also maintains more of the original image (avoids/reduces unnecessary losses) if the transformed image is not heavily filtered.

Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Aach and Neitzel as applied to claim 18 above, and further in view of U.S. Patent 5,461,655 to Vuylsteke et al. (Vuylsteke)

Aach further discloses that filter is dependent on a length and orientation of the pixel vector (col. 3, lines 22-35, Aach teaches that the weight factor is obtained by finding the direction in which the neighboring pixel is located in the current detail image with respect the to pixel being filtered (pixel of interest) and calculating the magnitude of

the difference between the pixels in said direction (pixel vector).) but does is silent with regard to the transformed image signal being obtained by convolution. However, Vuylsteke does disclose smoothing using a convolution filter (col. 11, lines 57-60).

The teachings of Aach, Neitzel and Vuylsteke are combinable because they are all in the same field of endeavor, namely, processing of X-ray images, further Aach and Vuylsteke employ multiresolution decomposition in their methods. It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the orientation dependent filter taught by Aach be a convolution filter as taught by Vuylsteke because such filters are easily implemented using a computer and are extensively used in processing digital images.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. U.S. Patent 5,442,462 to Guissin is cited for teaching multi-directional smoothing and adaptive noise reduction. U.S. Patent 5,717,791 to Labaere is cited for teaching multiresolution decomposition. U.S. Patent 5,956,427 to Greenspan is cited for teaching pyramid image representation and directionally orientated filters. U.S. Patent 6,674,915 to Wang is cited for teaching steerable pyramids. U.S. Patent 5,050,227 to Furusawa et al. is cited for teaching smoothing tangential to a contour and edge detection.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anthony Mackowey whose telephone number is (703) 306-4086. The examiner can normally be reached on M-F 9:00-6:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amelia Au can be reached on (703) 308-6604. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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12/21/2004

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